Culture of Silence: Corruption when Customers' Reports are Strategic Substitutes

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Abstract

A primary means of bureaucratic oversight is customer complaints. For example, it would be almost impossible to effectively fight corruption, if the victims of corruption do not report corrupt conduct. Yet, this important role of the victims of corruption has received very little attention in the literature on corruption. In this paper, I study a model of corruption with incomplete information in which customers require a government service from officials who may be corrupt. A victim of corruption can report corrupt officials to the higher-ranking officials who may be corrupt or honest; the reports of the victims are credible. Reporting corruption is a positive externality because it offers information about an official's type to other customers. This is due to a strategic substitutability among the reports of customers that arises naturally from Bayesian updating. This strategic substitutability leads an effect akin to free-riding on the information of others and therefore can lead to very few reports. A numerical example reveals that it is possible to have a locally stable equilibrium in which 90% of supervisors are honest but relatively very few customers (17%) are willing to report corrupt conduct even though the customers believe that 71% of *corrupt* officials have honest supervisors. Under certain conditions, there is, surprisingly, a unique equilibrium in which no one reports corruption *regardless* of the proportion of honest supervisors (i.e., higher-ranking officials), although all lower-ranking officials are corrupt. I construct examples in which social welfare is increasing in the equilibrium level of reports while in others, it is decreasing in the equilibrium level of reports.

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"*AN ACT to provide for the manner in which individuals may in the public interest disclose information that relates to unlawful or other illegal conduct or corrupt practices of others; to provide for the protection against victimisation of persons who make these disclosures; to provide for a Fund to reward individuals who make the disclosures ....*" --- Whistleblower Act 720, Parliament of the Republic of Ghana, October 16, 2006.

1. Introduction

Government corruption can be defined as "the sale by government officials of government property for personal gain" (Shleifer and Vishny, 1993). In many less-developed countries, one must pay a bribe to obtain a routine government service such as getting a child into a public school, a driver's license, a building permit, a passport, a birth certificate, clearing goods at customs, etc. There is, of course, corruption in developed countries even if to a lesser extent.

Studies have found that corruption has a negative effect on economic performance (e.g., Mauro, 1995; Bardhan, 1997). Policies to control corruption include monitoring, functional rotation of bureaucrats, efficiency wages, encouraging whistle blowers, etc (see, for example, Klitgaard, 1988). In addition to these factors, a primary means of bureaucratic oversight is customer complaints. If the victims of corruption do not report corrupt conduct, it would be almost impossible to effectively fight corruption.[1] For example, Ghana's Whistleblower Act referred to above seems to recognize this point. Yet, this crucial oversight role by customers of government services has received *very little* attention in the literature.[2] This paper studies the role of customer complaints in the fight against corruption.

Honest supervisors of corrupt officials can control the behavior of their subordinates but their ability to do so is hampered if the victims of the officials' corrupt behavior do not report

[1] In a related but different context, Brunneti and Weder (2003) find, in an econometric study of 125 countries, that increasing press freedom reduces levels of corruption.

[2] There is a small literature on whistleblowers. But it focuses on *employees* as whistleblowers.

such incidents to the supervisors of the corrupt officials. However, the victims need to feel that their complaints will be taken seriously lest their complaints become a waste of their valuable time. Thus customers are more likely to complain if they believe that a corrupt official's superior is honest. In this paper, I study a simple model of corruption in which victims of corruption can report corrupt officials to higher-ranking officials; a high proportion of these higher-ranking officials may be honest; the reports of the victims are credible; honest higher-ranking officials fire corrupt subordinates who are reported without incurring any cost of investigation; and corruption takes the form of "corruption without theft".[3] These are very favorable conditions for fighting corruption. Yet, the paper shows that fighting corruption may still be very difficult under these favorable conditions because the victims of corruption are very reluctant to report it even if they believe that there is a very high chance of them getting redress.

More specifically, I study a model in which customers of a government service encounter corrupt officials whose superiors may be corrupt or honest. Whether a corrupt official's superior is corrupt or honest is known to the official but not to the customer. If an official's superior is honest, then his decision to demand a bribe depends on the probability that the customer will report him and the size of the bribe also depends on this probability. Reporting corruption is a positive externality because it conveys information to other victims. This is due to a strategic substitutability among the reports of customers that arises naturally from Bayesian updating. This strategic substitutability leads an effect akin to free-riding on the information of others and therefore can lead to very few reports. To elaborate, when an official demands a bribe from a customer, the customer must decide whether to incur the cost of reporting the official to his

[3] This terminology is due to Shleifer and Vishny (1993). It is refers to corruption where nothing is stolen from the state. A corrupt official, for example, charges the legal price for a government service, puts the entire revenue in state coffers, but also extracts a bribe from the customer for his private gain. "Corruption with theft" occurs when the official, for example, does not put the full revenue due to the state in the coffers of the state. In this case, he might charge the customer a price lower than the legal price and use the entire revenue for his private gain.

superior or not. This depends on the customer's posterior belief that the official's superior is corrupt. Paradoxically, it turns out this posterior belief is higher when the number of customers who are reporting such demands for bribes is higher. This is because for, a given bribe, an official who demands a bribe when there is a higher probability of being reported is more likely to have a superior who is also corrupt. Therefore, a customer is less likely to report corruption when the measure of other customers who report corruption is higher. Hence, the reports of customers are strategic substitutes.

A numerical example reveals that it is possible to have a locally stable equilibrium in which 90% of supervisors are honest but only a relatively very small proportion of customers (17%) are willing to report corrupt conduct even though the customers believe that 71% of *corrupt* officials have honest supervisors.[4] In addition, there is a unique equilibrium in which no one reports corruption *regardless* of the proportion of honest supervisors, although all officials are corrupt. A non-decreasing hazard rate of the distribution of the customers' valuations and another condition provide sufficient conditions for this equilibrium. In this equilibrium, corrupt lower-ranking officials nullify any effect of an increase in the proportion of honest supervisors on the incidence of corruption by reducing the size of the bribe and therefore making it not worthwhile for customers to report corrupt conduct. These very low levels of reports may explain why in spite of some of the best anti-corruption efforts (e.g., proportion of honest supervisors is 90%), corruption may persist in certain countries.

While strategic substitutability among the reports of the customers can lead to low equilibrium level of reports, it is not the only effect that drives this result. As the preceding

[4] In its first year, only five cases were reported under Ghana's Whistle Blowers Act of 2006: http://news.myjoyonline.com/news/200711/10417.asp

paragraph argues, a strategic response of corrupt officials to higher levels of vigilance also accounts for the low level of reports.

It turns out that by punishing customers who lodge unsuccessful complaints, the actions of a *small* proportion of corrupt officials (i.e., corrupt officials whose supervisors are also corrupt; call them C-type officials) can support systemic corruption by making it more attractive for other officials (i.e., officials whose supervisors are honest; call them H-type officials) to engage in corruption. In fact, regardless of their proportion, the C-type officials are the leaders of this system of corruption. The H-types are followers; they hide behind the C-types and take the bribe chosen by the C-types as given. The proportion of corrupt H-types depends on the size of the bribe that the C-types choose.

I find that in some cases, social welfare is increasing in the equilibrium number of reports while in others, it is decreasing in the equilibrium number of reports. In a model without reports of corruption or higher-ranking officials, Ahlin and Bose (2007) find that social welfare may be non-monotonic in the proportion of honest officials.

The key insight of this paper is that the fact that a lower-level official demands a bribe may itself be a signal of whether higher-ranking officials who are supposed to monitor him are also corrupt. This signal in an environment where a customer believes that other customers are more likely to report corruption may paradoxically lead to low levels of reports and high levels of corruption because a customer's report and the reports of other customers are strategic substitutes.[5]

To the best of my knowledge, the closest paper to my paper is Cadot (1987) who studies an interesting model in which customers can report a corrupt official to higher-ranking authorities.[6] However, it is important to note that the results of my paper are not obtained by Cadot (1987). Cadot's (1987) main results are that a higher discount rate, lower degree of risk aversion, and a lower wage rate induce an official to be more corrupt (i.e., demand a bigger bribe). In addition, he also found that there could be multiple equilibria in the level of corruption. These are interesting results but they are different from the results of this paper. While reporting corruption by customers is in Cadot's paper, its main role is to ensure that there is some probability of the official losing his job. The factors that affect the rate of customer reports, whether it is high or low, and why this might be the case are not the focus of Cadot (1987).

There are also differences between the structure of my model and the model in Cadot (1987). In his model, an important variable (i.e., the probability that an official will be reported conditional on demanding a bribe) is exogenous when higher-ranking officials are corruptible (i.e., section 7) and is endogenous when *all* higher-ranking officials are honest. In the latter case, the probability that an official's demand for a bribe will be rejected is endogenized. However, having rejected an official's demand, the customer obtains no pecuniary benefit from reporting corruption. Cadot (1987) assumes that a customer who rejects a demand for a bribe reports the

[5] It would appear that this result has the flavor of herding behavior in models of informational cascades pioneered by Banerjee (1992) and Bikhchandani, Hirshleifer, and Welch (1992). However, there are differences. In my model, the customers move simultaneously not sequentially. Besides, in models of informational cascades, the players imitate each other's actions. Hence, actions may be loosely described as strategic complements. In my models, actions are strategic substitutes. If customers were to move sequentially and could observe whether or not previous customers rejected an official's demand for a bribe, then subsequent customers will simply not buy from that official and may optimally wait till they can figure out who the honest officials are. There will still be low reports but this result will be due to a less interesting mechanism.

[6] Andvig and Moene (1990) study a model in which corrupt officials are reported by their non-corrupt colleagues *not* customers and all higher-ranking officials are honest. It focuses on multiple equilibria. Multiple equilibria were also found in Cadot (1987) and other papers on corruption. This is not the focus of my paper.

official to higher-ranking officials although he derives no explicitly-stated benefit from doing so. This implicit assumption may be justified as follows: in Cadot (1987) a customer rejects a bribe because, at the cost of losing the benefit of current consumption, he has the option of searching and meeting an honest official in the next period. But having rejected an official's demand for a bribe, we may assume that the official's attempted extortion triggers a sense of indignation in the customer which induces him to report the official even though he obtains no pecuniary benefit from doing so.

When an official demands a bribe in Cadot (1987), a customer does not have to update his belief about the type of the official's supervisor (higher-ranking official) because, in the model where the probability of being reported is endogenized, all supervisors are honest. Because there is heterogeneity among supervisors in my model, demanding a bribe provides some information to customers about an official's type which allows them to update their beliefs. As explained above, this leads to a strategic substitutability among customers' reports, an effect that is absent in Cadot (1987) and the few models that examine the role of customer complaints in bureaucracies.[7]

Mookherjee and Png (1992) compare the relative efficiencies of monitoring and investigation in controlling malfeasant behavior. Investigation is contingent on complaints by consumers. However, in their model, the probability of consumer complaints is exogenous, the regulator is not corrupt and there is no bribery. Prendergast (2002, 2003) considers a model of

[7] Furthermore, while Cadot (1987) endogenizes the bribe that corrupt lower-level officials demand, he does not endogenize the number of lower-level officials who choose to be corrupt. In this paper, I endogenize both variables. However, I do not explicitly model the behavior of higher-ranking officials. I simply assume that honest higher-ranking officials fire corrupt subordinates who are reported but corrupt higher-ranking officials do not. In Cadot (1987, section 7), a reduced-form relationship is used to describe the behavior of the number of corrupt higher-ranking officials. I consider a continuum customer types while Cadot (1987) considers a binary type space. In Cadot (1987), a customer's type is either "good" or "bad" with his type defined as the *prior* probability that he will pass an official eligibility test (e.g., exam) for a permit. In my model, a customer's type is his valuation of the government service.

consumer complaints about a government bureaucracy's service where the bureaucrat is not necessarily corrupt. One of his main results is that the threat of consumer complaints causes bureaucrats to inefficiently accede to consumer demands. In my model, acceding to consumer demands is not inefficient. His model one has one consumer, an agent (bureaucrat), and a principal (the bureaucrat's superior). Like Mookherjee and Png (1992), the principal is never corrupt. To elaborate, in Prendergast (2002, 2003), the consumer and bureaucrat are privately informed about what the correct allocation of a good from a bureaucrat to the consumer should be. The probability that the bureaucrat's superior (principal) will investigate the bureaucrat's allocation decision depends on the consumer's complaint. The bureaucrat may incorrectly allocate the good to the consumer in order to avoid a complaint[8] and the consumer will not complain if this is the case. This is not the case in my model. In my model, consumers cannot use the threat of complaints to get the bureaucrat to make the wrong decision (i.e., incorrectly allocate the good). My results are also different from the results of these papers.

In the next section, I analyze a model of corruption with asymmetric information and customer complaints (reports of demands for bribes). Section 3 discusses the results and policy implications. Section 4 concludes the paper.

2. The Model

Consider a government agency with risk-neutral officials of unit measure who provide a service to risk-neutral members of the public (customers). Each official has a superior who is corrupt or honest. Call an official whose superior is honest a type-H (also H-type) official and if

[8] The bureaucrat does not know with certainty that he has incorrectly allocated the good because, conditional on exerting effort, he only gets a signal of the true state of the world (e.g., does the consumer's medical condition require surgery? or is he eligible for unemployment benefits?). However, when a complaint triggers an investigation, the (honest) principal will find out the true state.

his superior is corrupt call him a type-C (also C-type) official. An official's type is his private information and the proportion of officials with an honest superior is $\pi \in (0,1)$. Alternatively, one may assume that there is single superior who colludes with a proportion $1 - \pi$ of officials (his subordinates) in corrupt transactions and shares the rents from bribery according to some exogenous formula. However, this superior is tough on the other officials of size π. This may be the superior's ploy of masquerading as an honest official. I follow the former interpretation of π.

Each type-H official's per-period valuation of his job is s, where s is distributed on $[\underline{s}, \overline{s}]$ with continuous density $f(s) > 0$ and distribution function F(s); $\underline{s} \geq 0$.[9] As in Andvig and Moene (1990) and Cadot (1987), assume that each official has an *infinite horizon* and can serve only one customer per period. The discount factor is $\delta \in (0,1)$. Assume that when a type-H official demands a bribe and is reported, he is fired immediately but he keeps all the previous bribes collected.[10] A type-C official is not punished and his superior does nothing about customers' complaints.

There is a unit measure of risk-neutral customers each with valuation, v, for the service, where v is distributed on $[\underline{v}, \overline{v}]$ with continuous density $g(v) > 0$ and distribution function G(v); $\underline{v} \geq 0$ and $\overline{v}$ may be very large. A customer's valuation is his private information.

There is a bribe, b, which may be demanded by a corrupt official.[11] The official price of the service is $k \geq 0$. Therefore, a customer who pays a bribe pays a total price of

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[9] Alternatively, I could have assumed that there is only one official and nature independently draws his valuation (type), s, from the continuous distribution f(s) on the support $[\underline{s}, \overline{s}]$ and then draws the type of his superior from the binary distribution pr(H) = $\pi \in (0,1)$, where both types are the official's private information.

[10] As in Cadot (1987), assume that when an H-type official is fired, he is replaced by a random selection from the same population. And since an official deals with a customer at a time in his office, we may assume that firings are not observed by customers who are yet to be served. These latter assumptions are not crucial. Immediate dismissal is also the case in Andvig and Moene (1990). But in Andvig and Moene (1990), the bribe collected may be confiscated because in their model it is co-workers, not customers, who report corruption after the official has *actually* collected a bribe from a customer. The bribe is confiscated if the co-worker is honest.

[11] Later, I shall show that the size of the bribe will be same for all corrupt officials.

k + b for the service. A corrupt official puts the revenue collected from charging the official price into government coffers but the bribe is his private gain. This is why my model is a model of "corruption without theft." It also explains why, relative to the case where a customer does not pay a bribe, the official cannot give the customer a deal which is mutually beneficial to both parties.[12] As noted in Shleifer and Vishny (1993), 'corruption without theft" is easier to control than 'corruption with theft". However, I shall show that the latter type of corruption can still present daunting challenges. Without loss of generality, I set k = 0.[13]

I assume that after an initial (costless) contact with an official, the cost of further search is so high that if the official turns out to be corrupt, customers do not continue to search till they meet an honest official. This assumption is necessary in order to build a model that allows reports by customers to play a meaningful role. Since the customers only report an official's demand for a bribe with the hope of meeting an honest superior, it follows that allowing customers to keep searching for an official till they meet an honest official makes reporting by customers redundant in the model,[14] which is an undesirable feature of a model that

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[12] Customers benefit from corruption in Andvig and Moene (1990) because their model is a model of "corruption with theft."

[13] Note that in some developing countries, public elementary school education is free (i.e., k = 0). However, officials of the school may demand a bribe before admitting one's child.

[14] In Cadot (1987), customers have the option of searching till they meet an honest official. However, by assuming that a customer who rejects a bribe reports corruption even though he derives no pecuniary benefit from doing so, Cadot (1987) avoids the problem of redundancy of customer reports.

purports to examine the role of customer reports in fighting corruption.[15] Furthermore, there are certain services for which you cannot search even if the cost of search is costless. For example, when an immigration official, customs official, or an official who issues passports demands a bribe, you cannot go to another official because the original official will not transfer your file and once he has denied your application, another official may not process your application *unless* you lodge a formal and successful complaint to a higher-ranking official.[16]

Cadot (1987) implicitly assumes that customers who pay a bribe and therefore obtain the service do not report corruption. To get a similar effect, I assume that a customer who pays a bribe and then reports the official does not get his bribe refunded even if the official's superior is honest.[17] This may be because of the lack of funds and the difficulty of retrieving the bribe from the official. Indeed, if the official is fired for receiving a bribe, he will be reluctant to return the bribe because he gains nothing from doing so. In my model, customers do not report an official out of spite or hatred, so their reports are credible. Therefore, as in Cadot (1987), customers who

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[15] To elaborate, consider the following quote in Shleifer and Vishny (1993, p. 607): "A citizen can obtain a U.S. passport without paying a bribe. The likely reason for this is that if an official asks him for a bribe, he will go to another window or another city. Because collusion between several agents is difficult, bribe competition between the providers will drive the level of bribes down to zero." Therefore, very small search costs and competition among corrupt officials will eliminate corruption (bribery in this case). However, the goal of this paper is to study corruption in an environment where the customers that government officials serve can report corruption. It is impossible and meaningless to build such a model if very small search costs, competition, and no reporting by customers are enough to eliminate corruption. Therefore, I need a model in which customer reports may play a role in reducing corruption. To do so, I simply assume that the cost of search is sufficiently high, which restricts the customer to the following options: (a) don't pay the bribe and report the demand for the bribe or (b) pay the bribe. This limited set of choices biases the model towards reporting bribes. Yet, as I show, there are equilibria with very low levels of reporting.

[16] I thank Henry Thille for this point.

[17] Without this assumption, we may have the trivial "equilibrium" in which every customer pays a bribe when an official demands it, gets the service, and then reports the demand for a bribe regardless of the parameters of the model. This high level of reports is clearly at odds with casual empiricism. Also, this cannot be an equilibrium because if every customer reports a demand for a bribe, then only C-type officials will be corrupt. But then it is not an equilibrium response by the customers to report corruption. Of course, this simply means that there is no pure-strategy equilibrium in which all customers are willing to report corruption. Notice that there cannot be an equilibrium in mixed strategies for customers because, for a given b, when a customer with valuation, $\tilde{v}$ is indifferent between reporting and not reporting, then this condition will not hold for other customers.

intend to report a demand for a bribe will not pay the bribe upfront and those who have already paid a bribe do not report corruption.

Without loss of generality, I assume that the bribe demanded by a C-type official is kept by him even if he is reported to his superior. Assuming that there is some exogenous division of the bribe between a C-type official and his superior will not affect the analysis.

The timing of actions is as follows:

1. Each customer (atomistic) forms an expectation of the measure of other customers who will report a demand for a bribe. This is the probability that an official who demands a bribe will be reported.

2. Without observing an official's bribe or his type, customers sequentially approach an official for the government service; an official may serve more than one customer.

3. When a customer meets an official, the official -- based on the probability of being reported in stage 1 -- *determines the size* of his bribe and, of course, *demands* that bribe. The customer then has two choices: (a) refuse to pay the bribe and report the official; or (b) pay the bribe and not report the official.

4. Payoffs for the customer and official are realized; if the official is not fired, another customer approaches him and we repeat the process starting in stage 3. If the official is fired he is, as previously, stated replaced by another official who is randomly chosen from the same population.

Before I proceed to the solution of the model, it is important to reiterate that customers who have not paid a bribe and report corruption receive a reward (i.e., if they report a type-H official, they are rewarded by getting the service without paying a bribe). Customers who paid a bribe are not rewarded for reporting corruption. While I claim that my model examines corruption under favorable conditions for fighting corruption, one may argue that certain assumptions (e.g., those who paid a bribe are not rewarded for reporting corruption, customers cannot search, etc) make it difficult to fight corruption. I agree with this argument but it must also be borne in mind that a model which claims to have favorable conditions for fighting corruption cannot be a first-best model because the problem then becomes trivial. For example, it is obvious that corruption can be eliminated by combining a small audit or monitoring probability with a very high fine or very severe punishment for offenders. However, there are *standard* second-best arguments (e.g., wealth constraints of offenders) in the law and economics literature for why this solution cannot or should not be implemented. So, in spite of some favorable conditions for fighting corruption in my model it is, like all models of corruption, a second-best model with certain frictions. But these frictions were not chosen arbitrarily. They were chosen with the goal of constructing a second-best model that rules out the attainment of a first-best outcome through certain well-known channels (e.g., introducing competition among government officials by allowing customers to search) and thus give a *possible non-trivial role to customer complaints in fighting corruption*.[18]

2.1 Equilibrium analysis

I look for a perfect Bayesian equilibrium in pure strategies. The payoffs of the players are as follows: if a customer does not consume the service, his payoff is zero. If he reports a demand for a bribe and the official's superior is honest, his payoff is v because the gets the service without paying a bribe; if the superior is corrupt, nothing is done about his complaint and he gets

[18] For example, Lazear (2006) assumes exogenous fines/punishment in order to focus on alternative measures of dealing with malfeasant behavior. The same is also true in Cadot (1987) and many models of corruption.

zero.[19, 20] If he does not report the demand for a bribe, then he pays the bribe and gets $v - b$ if $b \leq v$; if $v - b < 0$ and he does not report the demand for a bribe, he goes without the service and so his payoff is zero.

Let $r \in [0,1]$ be the probability that an official who demands a bribe will be reported by the customer. This is the measure of customers who will report an official *if* the official demands a bribe.

Definition: A pure-strategy perfect Bayesian equilibrium of this game is a bribe-report probability pair, (b*, r*), and customers' beliefs about an official's type such that (i) given (b*, r*) and customers' beliefs, each official chooses to be corrupt or honest, where honest officials choose a zero bribe, corrupt officials choose $b^* \geq 0$,[21] and no official has the incentive to change his bribe, (ii) given (b*, r*) and a customers' beliefs, each *atomistic* customer maximizes his payoff by choosing whether or not to report an official if the official demands a bribe; (iii) given b*, the measure of customers in (ii) who will report corruption is indeed r*, and (iv) whenever possible, the customers' beliefs are derived from the officials' strategies using Bayes' rule.

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[19]In general, what we need is that a customer's payoff after an unsuccessful complaint (i.e., if the official is type-C) is lower than his payoff after a successful complaint (i.e., if the official is type-H). To make the analysis meaningful, there must be a cost to unsuccessful complaints. Otherwise, all customers will always complain (i.e., report corrupt officials) in any equilibrium, which will not be a desirable feature of the model. Unsuccessful reports only occur when the official is type-C.

[20]This is based on the assumption that a disgruntled customer is not served by a type-C official. This may be due to the following reasons: (a) type-C officials feel insulted by a customer's rejection of their demand for a bribe and the customer's audacity to report them. This is similar to the argument I have used to justify Cadot's (1987) implicit assumption that a customer reports corruption although there is no pecuniary benefit from doing so, (b) type-C officials may want to deter customers from engaging in an activity (i.e., complaints) that only result in delays in the payment of bribes, and (c) a (disgruntled) customer who has reported a demand for a bribe is one who is not a trust-worthy "partner" in an illegal activity. Even in highly corrupt countries, there are a few corrupt officials who are periodically used as scapegoats; these are typically bureaucrats as opposed to politicians. So those who engage in bribery cannot be reckless. Besides, those who are able to escape justice are the very powerful and influential politicians and bureaucrats. Most officials, in charge of issuing permits or providing other government services, and their immediate superiors do not typically have this clout. Such corrupt officials need the trust of customers to engage in corruption. It takes two to tango.

[21] Of course, $b^* = 0$ is a *degenerate* case. I discuss this equilibrium in a footnote.

In what follows, I focus on equilibria with $b > 0$. Stage 4 is trivial. I solve the game in stage 3. In stage 3, I focus on an official's sub-decision to demand a bribe or not, so I shall treat the bribe as exogenous and later endogenize it. I shall later show that all corrupt officials will demand a bribe of the same size (a pooling equilibrium) and that the bribe is exogenous to H-type officials because they will simply choose the bribe set by C-type officials. Therefore, I begin by using an exogenous bribe of common size for H-type officials. This, of course, means that in a pooling equilibrium, we have to show that, *for H-type officials who choose to be corrupt*, $b(s) = b > 0 \;\forall s$.

Consider type-H officials in stage 3. Customers approach an official sequentially and since they do not observe an official's type or bribe, they approach officials randomly. To an H-type official, each customer's type is an identical and independent draw from the same distribution. Therefore, a type-H official's belief of the probability that a customer will report a demand for a bribe is the same for each customer. Recall that an official who is reported is fired immediately and gets a payoff of zero thereafter but keeps previous bribes collected. Hence an official's decision to be corrupt in a given period is not influenced by previous bribes collected. Accordingly, for H-type official with valuation s, the Bellman equation for a corrupt strategy, noting that the bribe is exogenous, is $V_t = (1 - r)[(s + b) + \delta V_{t+1}]$, where V_t is the value function for period t. The preceding arguments, risk-neutrality, and infinite horizon imply that an official's problem is stationary. So imposing stationarity (i.e., $V_t = V_{t+1}$ for all t) gives the payoff from a corrupt strategy as $V^{*B} = (1 - r)(s + b)/[1 - \delta(1 - r)]$. It is easy to show that the payoff from a non-corrupt strategy is $V^{*NB} = s/(1 - \delta)$. Hence an H-type official with valuation s, will be corrupt if

$$V^{*B} \geq V^{*NB}. \tag{1}$$

Then the inequality in (1) implies that H-types with valuation $s \leq \hat{s}$ will demand bribes from their customers and those with $s > \hat{s}$ will not, where $\hat{s} \equiv (1 - \delta)(1 - r)b/r$. Therefore, the proportion of H-type officials who are corrupt is

$$\rho(r) = \int_{\underline{s}}^{\hat{s}} dF(s) = F(\hat{s}) = F\left(\frac{(1-\delta)(1-r)}{r} b\right). \tag{2}$$

Holding b fixed for now, we get

$$\frac{\partial \rho(r)}{\partial r} = -(1-\delta) b f(\hat{s}) / r^2 < 0. \tag{3}$$

Hence, the higher is the probability of being reported, holding b fixed, the lower is the measure of corrupt H-type officials. Also, the measure of corrupt H-type officials is increasing in the bribe.

Now consider the customers in stage 3. Given the strategy of H-types which, in the aggregate, is summarized in equation (2) and the fact that C-types always demand a bribe, a customer's belief that an official is an H-type given that he has demanded a bribe (db) is:

$$\lambda(b, r) \equiv \Pr(H | db) = \frac{\rho(r)\pi}{\rho(r)\pi + (1-\pi)}. \tag{4}$$

Unless it will lead to confusion, I shall write λ(b, r) as λ(r). Note that

$\lambda(r) - \pi = -\pi(1 - \pi)(1 - \rho(r))/\Delta < 0$, where $\Delta \equiv \rho(r)\pi + (1-\pi)$.

Holding b fixed, we get

$$\frac{\partial \lambda}{\partial r} = \frac{\pi \rho'(r)}{\Delta}(1-\lambda) < 0. \tag{5}$$

Hence, holding b fixed, the higher is a customer's belief of the frequency of reports, the higher is his belief that an official who demands a bribe is type-C. This is because for, a given bribe, an official who demands a bribe when there is a higher probability of being reported is more likely to have a superior who is also corrupt. The following derivative will be helpful in subsequent analysis:

$$\frac{\partial \lambda}{\partial \pi} = \frac{\rho(r)}{\Delta}\left(1 + \frac{\pi(1-\rho(r))}{\Delta}\right) > 0. \tag{5a}$$

A customer of type v for whom $v - b \geq 0$ will report a demand for a bribe if $\lambda(r)v + (1 - \lambda(r))(0) \geq v - b$. Also, customers with $v - b < 0$ will always report a demand for a bribe hoping to get an expected payoff of $\lambda(r)v + (1 - \lambda(r))(0) \geq 0 > v - b$. Therefore, in either case, a customer of type v will report a demand for a bribe if and only if

$$\lambda(r)v + (1 - \lambda(r))(0) \geq \max[0, v - b]. \tag{6}$$

The set of customers who satisfy the inequality in (6) have valuation $v \in [\underline{v}, \hat{v}]$, where $\lambda(r)\hat{v} + (1 - \lambda(r))(0) = \hat{v} - b$. This gives $\hat{v}(r) = b/(1 - \lambda(r)) > b$. Any customer with valuation $v \leq \hat{v}$ will report a demand for bribe and those with $v > \hat{v}$ will not. Hence,

$$r = \int_{\underline{v}}^{\hat{v}} dG(v) = G(\hat{v}(r)) = G\left(\frac{b}{1-\lambda(r)}\right). \tag{7}$$

The derivative in equation (5) drives the effect of the strategic substitutability among the reports of customers discussed in section 1.[22] This effect arises naturally through Bayesian updating. Noting that a customer is atomistic, the inequality in (6) shows that $\lambda(r)$ which influences a customer's decision to report a bribe depends on the aggregate reports, r, of *other* customers. Given a customer's valuation, the bribe, and $\lambda'(r) < 0$, the inequality in (6) shows that a customer will not report a demand for a bribe if his belief, r, that other customers will report corruption is sufficiently high. But if every customer held the same belief, then the probability that a customer will report corruption will actually be low. This is why, in equilibrium, strategic substitutability of reports could lead to very low reports. The handful of models, discussed in section 1, that consider customer reports do not have this social-interaction effect among reports. In these models, a customer's reporting decision is independent of the aggregate reports of other customers. Strategic complementarities -- but *not* among the reports of customers or employees -- sustain multiple equilibria in Cadot (1987) and Andvig and Moene (1990).

2.1.1 Endogenizing the bribe

The inequality in (1) determines whether an H-type official demands a bribe or not. But what should be the size of the bribe? Accordingly, consider the sub-decision in stage 3 where an official, including C-types, chooses the size of the bribe. Because a customer cannot go to another official once he has approached a given official, each official has monopoly power. So it is reasonable to assume that an official can choose the size of the bribe. Since each customer

[22] If I had assumed a single customer whose type is independently and identically drawn each period from G(v) and is his private information, my results would still have gone through but the interpretation of strategic substitutability of customers' reports would have been lost. In the case of single customer, we will still get the result that $\lambda(r)$ is decreasing in r but we would have to interpret this as follows: the higher is the customer's belief of the official's belief that his demand for a bribe will be reported, the lower is the customer's belief that the official's supervisor is honest. In equilibrium, the customer and official must have the same belief. However, in terms of trying to understand corruption -- a phenomenon that involves social interactions at different levels -- it is better to get insights into the interactions among customers, among officials, and between officials and customers. Therefore, the assumption of multiple customers strikes me as more realistic.

approaches an official without knowing his type or the size of the bribe he has chosen, it follows in stage 2 each customer *randomly* approached an official. This makes the decision in stage 2 trivial.

It is important to note that corrupt H-type officials cannot choose a bribe different from the bribe chosen by C-types because they would reveal their type if they did so.[23] Hence, they are forced to choose the bribe chosen by C-types, so long as the inequality in (1) is satisfied. Therefore H-types do not determine the bribe. The C-types choose the bribe and the H-types take it as given.[24] Therefore, for corrupt H-type officials, $b(s) = b \ \forall s$. The C-types are the leaders and the H-types are the followers.

Accordingly, consider a C-type official's choice of bribe in stage 3. Note that C-type officials do not worry about the risk of being caught but they take r into account because they want to reduce the measure of disgruntled customers since the presence of these customers leads to a loss of income; they do not serve these disgruntled customers as explained in a previous footnote (i.e., note 20).[25] We may write the Bellman equation for a type-C official as

[23]To elaborate, there cannot be an equilibrium with different but positive bribes because in such an equilibrium consistency of beliefs requires that types must be revealed. However, H-type officials who choose to be corrupt will not reveal their type by choosing a positive bribe which is different from the bribe chosen by C-type officials. If they did, they will be reported with certainty if they demand a bribe.

[24]Since the preceding footnote shows that there cannot be an equilibrium with different but positive bribes, let's consider an alternative scenario where H-type officials choose a common bribe that is *different from the preferred bribe of the C-types* and the C-types are forced to choose this bribe because they do not want to reveal their type and have their bribe demand rejected. This scenario is not possible because given that the customers (a) approach an official without knowing his bribe or type, (b) cannot get the service from another official once they have already approached an official, and (c) gain nothing from reporting a C-type official, the customers will **not** refuse to get the service from a type-C official if he reveals his type by demanding a bribe different from the bribe of H-type officials. If they refuse the service from a C-type official, it would not be because the bribe is believed to be different from the bribe chosen by H-type officials but because the bribe satisfies the inequality in (6). Therefore, corrupt type-H officials must choose the bribe chosen by type-C officials.

[25]Also, as indicated earlier, without this feature, the customers will incur no cost of unsuccessful complaints. If there is no cost of unsuccessful complaints, then we get the obvious and trivial situation where every customer will not pay the bribe upfront and will always report an official who demands a bribe. But as lemma 1 shows this cannot be an equilibrium.

$\Omega_t = (1 - r)[(z + b) + \delta\Omega_{t+1}] + r[z + \delta\Omega_{t+1}]$, where Ω_t is the value function for period t and z is a type-C official's valuation of his job.[26] As before, imposing stationarity (i.e., $\Omega_t = \Omega_{t+1}$ for all t) gives $\Omega = [b(1 - r) + z]/(1 - \delta) = [b(1 - G(\hat{v}(r)) + z]/(1 - \delta)$.[27] Hence, given r, C-type officials choose the bribe to maximize the expected income

$$\Omega = b(1 - G(\hat{v}(r))/(1 - \delta) + z/(1 - \delta) \tag{8}$$

Intuitively, the total measure of customers who are willing to pay a bribe without reporting corruption is $1 - G(\hat{v}(r))$. Therefore, given that a customer randomly approaches an official, each corrupt official expects the $1 - G(\hat{v}(r))$ bribers to be uniformly distributed over all officials.[28] Since the total mass of officials is 1, it follows that a corrupt official's expected bribe income is $b(1 - G(\hat{v}(r))$. Maximizing this expression will give the same optimal bribe as maximizing the payoff in (8). Note that optimal bribe is independent of z, δ, and whether a type-C official transfers some fixed proportion of every bribe to his superior. Since the bribe is independent of z, all C-types will indeed choose the same bribe. In what follows, I set $\delta = z = 0$ when writing the maximand for type-C officials.

The following lemma is useful in subsequent analysis:

Lemma 1: *There is no equilibrium with $b > 0$ in which all customers are willing to report corruption.*

Proof: Suppose $r = 1$ and $b > 0$. Then no H-type official will be corrupt. However, given that no H-type official is corrupt, it is not an optimal response for any customer to report corruption since any official who demands a bribe must be a C-type. Hence, $r = 1$ and $b > 0$ cannot be an

[26] Setting $z = s$ will not change the analysis. The current formulation is only to ease exposition.
[27] This is similar to the maximand in Cadot (1987) with the crucial difference that because there are no C-types in his model, the official is scared of being fired and also there is no strategic substitutability of customers' reports.
[28] Note that the $G(\hat{v}(r))$ measure of customers -- who will report a demand for a bribe -- will also randomly approach officials.

equilibrium. **QED**

Note that the maximand in (8) is undefined for r = 0 since ρ(r) which affects $\hat{v}(r)$ through its effect on λ(r) is undefined for r = 0. Therefore given this observation and lemma 1, I optimize the maximand in (8) for $r \in (0,1)$ and later consider the case of r = 0.

The first-order condition for maximizing (8) is:

$$(1 - G(\hat{v}(r)) - bg(\hat{v})\hat{v}_b = 0 . \quad (9)$$

The second-order condition for a maximum gives

$$D \equiv -[2g(\hat{v})\hat{v}_b + b(\hat{v}_b)^2 g'(\hat{v}) + bg(\hat{v})\hat{v}_{bb}] < 0 . \quad (10)$$

Assuming that **Ω**(b) is strictly concave (i.e., D < 0) implies a unique solution $\hat{b} = \hat{b}(r) > 0$ to (9).[29, 30] Put $\hat{b} = \hat{b}(r)$ into (9) and take the derivative with respect to r to get

$$\hat{b}'(r) = \frac{g(\hat{v})\hat{v}_r + b\hat{v}_b\hat{v}_r g'(\hat{v}) + bg(\hat{v})\hat{v}_{br}}{D} . \quad (11)$$

[29] While for modeling purposes, it might be necessary to assume that an official demands a bribe of a given size, it is important to note that in some developing countries, it is not always the case that corrupt officials explicitly state the size of the bribe that they want. There appears to be a social norm of the acceptable size of the bribe that customers are expected to pay. In addition, the officials need not explicitly demand a bribe. Corrupt officials use delaying tactics and cumbersome bureaucratic procedures to signal to customers that they want a bribe. The customers understand this social norm and what the acceptable size of the bribe is. Therefore, in our context, one may imagine that a corrupt official may demand a bribe without stating the size of the bribe but a customer mindful of the maximand in (8), a proxy for a social norm, offers an acceptable bribe. Such social norms also mean that the size of the bribe for a given service is approximately the same for each corrupt official. If corrupt officials do not explicitly ask for a bribe then, without having actually paid a bribe, proving that an official has demanded a bribe is very difficult. If one were to incorporate this into the model, it will reduce the frequency of reports and strengthen the results of this paper.

[30] There is a contrived and degenerate equilibrium in which r = 1 and all officials (including C-type officials) do not demand a bribe (i.e., b = 0). When an official deviates to some b > 0, the most advantageous belief is when customers believe that he is a C-type official. Therefore, both C-type and H-type officials will deviate. Hence, the intuitive criterion has no bite and so we can support this equilibrium with the out-of-equilibrium belief that customers believe that when an official deviates to demand a positive bribe, that official must be an H-type. Note that in equilibrium, C-type officials are indifferent between deviation and non-deviation because in either case, their payoff is zero. For any positive out-of-equilibrium belief that an official who deviates is a C-type, C-type officials are no longer indifferent and will deviate with certainty. The same is not true of H-types. Therefore, applying the D1 condition in Cho and Kreps (1987) which requires that we put the *entire* weight on the type that is willing to deviate for a wider range of inferences by the receiver, this equilibrium with b = 0 and r = 1 breaks down. In any case, I focus on equilibria with b > 0 since that is more consistent with empirical facts (i.e., there is some corruption in almost every country).

Note that $\hat{v}_r \equiv \partial\hat{v}/\partial r < 0$ since $\lambda'(r) < 0$. However, $\hat{v}_b \equiv \partial\hat{v}/\partial b$ has an ambiguous sign because while an increase in the bribe has the direct effect of increasing the measure of customers who want to report corruption, it also has the opposing effect of reducing this measure of customers through its effect on λ because an increase in the bribe increases the measure of corrupt H-type officials which increases the customer's posterior belief (i.e., λ) that a corrupt official is type-H. The magnitude of this latter effect depends on the density function, f(s). Also, $g'(\hat{v})$ and the cross-partial $\hat{v}_{br}$ have ambiguous signs. In general, the derivative in (11) has an ambiguous sign. However, if $\hat{v}_b g'(\hat{v}) \geq 0$ and $\hat{v}_{br} \leq 0$, then this is sufficient for $\hat{b}(r)$ to be an increasing function of r.[31] To see the intuition behind $\hat{v}_{br} \leq 0$, fix b. An increase in r reduces $G(\hat{v}(r))$ because according to (3), $\lambda'(r) < 0$. This increases $1 - G(\hat{v}(r))$. That is, an increase in the probability of reporting an official reduces a customer's belief that an official who demands a bribe is a type-H official (i.e., $\lambda'(r) < 0$) and so it increases the supply of customers who are willing to pay a bribe. Therefore, the size of the bribe can increase without substantially reducing the measure of customers who are willing to pay a bribe. If $\hat{v}_{br} \leq 0$ and is sufficiently small, then the increase in r can mitigate the negative effect of an increase in the bribe on the measure of customers who want to pay the bribe.[32]

[31] In simulations, I was not able to find an example where the bribe was not an increasing function of r. We can also explain the intuition for our result by appealing to the intuition in Bose (2004) who found a similar result where a corrupt official with monopoly power responds to increased vigilance of his behavior (similar to an increase in r) by increasing the size of the bribe per transaction but reduces the number of corrupt transactions (similar to a fall in the number of corrupt officials in this model). This is because, in his model, the probability of being caught is increasing in the number of corrupt transactions that he is involved in. So when vigilance increases, he reduces the number of corrupt transactions but increases the bribe per corrupt transaction.

[32] Section 2.1.3 gives an example of a $\hat{b}(r)$ function which is increasing in r on the domain [0,1).

2.1.2 Closing the model

An equilibrium of this game is a set of beliefs and a (b, r) pair that satisfies equations (7) and (9). The solution to equation (7) is a fixed point: $r = G(\hat{v}(r))$. As is standard in these models, this fixed-point can be seen as a rational-expectations equilibrium in which each agent, in his decision-making calculus, forms an expectation of the aggregate reports and, in equilibrium, this expected aggregate report becomes the actual aggregate report. Strictly speaking, each agent forms an expectation, r_e, of the aggregate measure of customers who are willing to report corrupt conduct. This then determines actual reports $G(\hat{v}(r_e))$, and so in a rational-expectations equilibrium, we want $r = r_e$. Hence, we impose the condition $r = r_e$ on $r = G(\hat{v}(r_e))$ and simply write this condition as $r = G(\hat{v}(r))$.[33]

Finally, consider stage 1 where the equilibrium measure of reporters is determined. As noted above, the solution $(\hat{b}, \hat{r})$ to equations (7) and (9), if it exists, and a set of beliefs give the equilibrium of the game. If the condition in (10) holds, then there exists a unique solution $\hat{b} = \hat{b}(r)$ to equation (9). I now specify sufficient conditions for a solution to equation (7).

Recall that $\rho(r)$ which affects $\hat{v}(r)$ through its effect on $\lambda(r)$ is undefined for r = 0 and according to lemma 1, r = 1 is not an equilibrium. In order to find a fixed point of $G(\hat{v}(r))$ over a compact and convex set, consider some interval $[\underline{\varepsilon}, \overline{\varepsilon}]$, where $0 < \underline{\varepsilon} < \overline{\varepsilon} < 1$. Put $\hat{b} = \hat{b}(r)$ into $G(\hat{v}(r))$. Suppose that $G(\hat{v}(r))$ is non-decreasing in r, $G(\hat{v}(\underline{\varepsilon})) > \underline{\varepsilon}$ and $G(\hat{v}(\overline{\varepsilon})) < \overline{\varepsilon}$. Then $G(\hat{v}(r))$ has a fixed point, $\hat{r} \in (\underline{\varepsilon}, \overline{\varepsilon})$.

Put $\hat{b} = \hat{b}(r)$ into $G(\hat{v}(r))$ and differentiate to get

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[33] See also Andvig and Moene (1990), Amegashie (2008), Alesina and Angelotos (2005), and Lindbeck, Nyberg, and Weibull (1999).

$$\frac{\partial G(\hat{v})}{\partial r} = \frac{g(\hat{v})}{1-\lambda(r)}\left(\frac{\hat{b}(r)\lambda'(r)}{1-\lambda(r)} + \hat{b}'(r)\right). \tag{12}$$

We know that $\lambda'(r) < 0$. So if $\hat{b}'(r) > 0$ is *sufficiently* high and the absolute value of $\lambda'(r) < 0$ is *sufficiently* small, then the derivative in (12) will be non-negative which ensures that there exists a solution $\hat{r} \in (\underline{\varepsilon}, \bar{\varepsilon})$ to equation (7), where $0 < \underline{\varepsilon} < \bar{\varepsilon} < 1$.[34]

To support a pooling equilibrium, I consider the following out-of-equilibrium beliefs: Suppose an official deviates from the equilibrium bribe. The most favorable scenario is for the customers to believe that he is a C-type. Then no C-type officials will deviate because, given that the bribe maximizes (8), they will be worse off by deviating. Since in a pooling equilibrium $\lambda(r) > 0$, H-types have the incentive to deviate if a customer will think that they are C-types. Hence, in the spirit of the Cho-Kreps intuitive criterion, a customer who observes a deviation must believe that the official is an H-type. Accordingly, we can support a pooling equilibrium with $b > 0$ by assuming that a deviation to a different bribe is believed by the customers to have been made by an H-type. I now state the following proposition:

Proposition 1: *Suppose that (10) holds, so that there is a unique interior solution,* $\hat{b} = \hat{b}(r)$, *to equation (9). If (i) the continuous distribution function* $G(\hat{v}(r))$ *is non-decreasing in* r, *and (ii)* $G(\hat{v}(\underline{\varepsilon})) > \underline{\varepsilon}$, $G(\hat{v}(\bar{\varepsilon})) < \bar{\varepsilon}$, *where* $0 < \underline{\varepsilon} < \bar{\varepsilon} < 1$, *then* $G(\hat{v}(r))$ *has a fixed point,* $\hat{r} \in (\underline{\varepsilon}, \bar{\varepsilon})$, *which is the equilibrium measure of customers who are willing to report corruption and* $\hat{b} = \hat{b}(\hat{r})$ > 0 *is the equilibrium bribe chosen by corrupt officials. Each customer's beliefs are* $\lambda(\hat{b}, \hat{r}) = \pi\rho(\hat{r})/[1-\pi+\pi\rho(\hat{r})]$ and $\lambda(b, \hat{r}) = 1$ for $b \neq \hat{b}$.

[34] I shall construct specific examples of the equilibrium of the model.

It is important to note that the conditions in proposition 1 are *not* necessary conditions for $G(\hat{v}(r))$ to have a fixed point. They are only sufficient conditions. Later, I shall construct specific examples which show that $G(\hat{v}(r))$ is non-decreasing in r and that there exist (b, r) pairs that are solutions to equations (7) and (9) and satisfy the conditions in proposition 1.

Finally, I state the following proposition:

Proposition 2: *Suppose* $1 - \tilde{b}\,\theta(\tilde{b}) \leq 0$ *for* $\tilde{b} \equiv b/(1-\pi) \in [\underline{v}, \overline{v}]$, where $\underline{v} > 0$ and $\theta(v) \equiv g(v)/[1 - G(v)]$ *is the hazard rate of the distribution of customers' valuations. Then regardless of* F(s) and $\pi \in (0,1)$, *there is a unique equilibrium in which all officials are corrupt, all customers pay a bribe, and no customer reports corruption.* That is, $r^* = 0$, $b^* = (1 - \pi)\underline{v} > 0$, and $\rho^* = 1$ *is the unique equilibrium. A customer's belief that a corrupt official has an honest supervisor is* π *and any official who demands* $b \neq b^*$ *is believed to have an honest supervisor.*

Proof: See Appendix A.

It is interesting to note that the sufficient conditions for the equilibrium in proposition 2 are implied by a non-decreasing hazard rate (i.e., $\partial\theta(v)/\partial v \geq 0$),[35] and $1 - \underline{v}\,\theta(\underline{v}) \leq 0$. Note that $b^* = 0$ if $\pi = 1$ because, in this case, all officials are H-types.

2.1.3 Examples of interior solutions and proposition 1

In this section, I present examples of equilibria which are not corner solutions (i.e., $r \neq 0$). I check that the following feasibility conditions are satisfied: $\hat{v} \equiv b/(1 - \lambda(r)) \in [\underline{v}, \overline{v}]$ and $\hat{s} \equiv (1 - \delta)(1 - r)b/r \in [\underline{s}, \overline{s}]$.

[35] This is a standard regularity condition (i.e., *monotone hazard rate* condition) in several areas of economics (e.g., in auction theory).

Example 1 below does not illustrate proposition 1 because I could not get a closed-form solution for $\hat{b}$ as a function of r. Instead, I illustrate proposition 1 in example 2 below.

Example 1: Suppose that δ = 0.1 and π = 0.9.[36] Let g(v) = 2v on [0,1], which gives $G(v) = v^2$. Similarly, f(s) = 2s on [0,1] with $F(s) = s^2$. Then $\hat{b}$ = 0.1198 and $\hat{r}$ = 0.1712.[37] This gives $\rho(\hat{r})$ = 0.2726.[38] Setting r = 0.1675 and plotting **Ω**(b) on [0,1] shows that it is a strictly concave function.

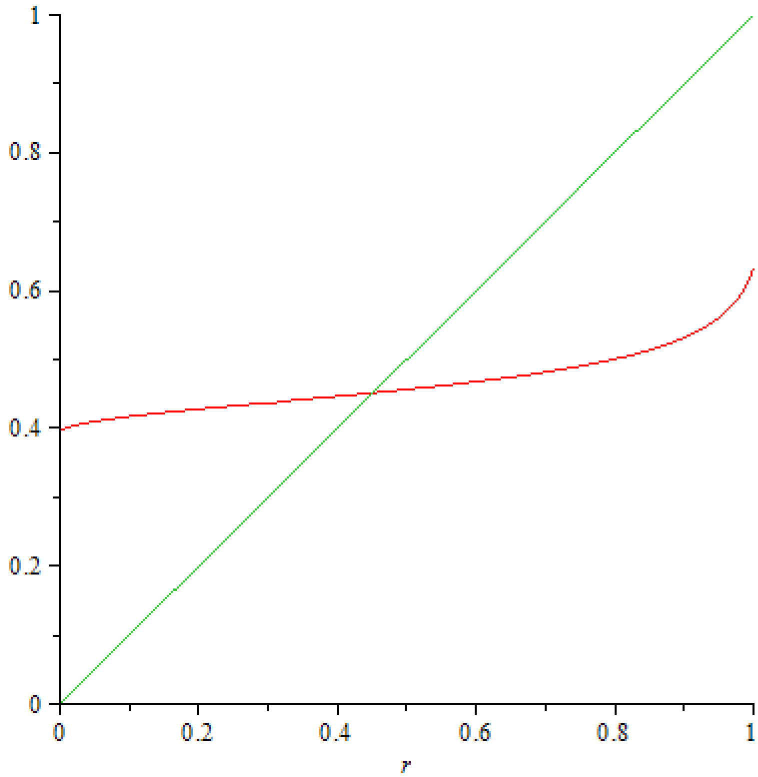
Example 2: Let δ = 0.1 and π = 0.9. Suppose that v follows an exponential distribution with support $[0,\infty)$ and distribution function G(v) = 1 − exp(− v) and s is uniformly distributed on [0,1]. In this case, we are able to obtain a closed-form solution for $\hat{b}$ (r) as follows:

$$\hat{b}(r) = \frac{0.06173\left(-0.5r + \sqrt{16.20r - 15.95r^2}\right)}{1-r}, \qquad (13)^{39}$$

which is increasing in r on the domain [0,1). A plot of $G(\hat{v}(r))$ and the 45-degree line gives figure 1 below which shows that $G(\hat{v}(r))$ is strictly increasing on the domain $r \in (0,1)$.

[36] This value of π is very high. However, I use it to make an important point in section 3.
[37] These values were obtained with the math software, *Maple*. It can be shown that for these distribution functions, the equilibrium in proposition 2 does not exist. See more examples in table 1.
[38] In addition to this (b, r) solution, *Maple* gave nine other (b, r) solutions which were complex roots and one other real root which had a negative value for the bribe.
[39] Equation (9) has two roots but one of them is negative.

Figure 1: Plot of 45-degree line and $G(\hat{v}(r))$ given $\delta = 0.1$, $\pi = 0.9$, $G(v) = 1 - \exp(-v)$ on $[0, \infty)$ and $f(s) = s$ on $[0,1]$.



The point of intersection of the two curves is the unique[40] fixed point of $G(\hat{v}(r))$. It is easy to see from the diagram that $G(\hat{v}(r))$ is non-decreasing in r as required by proposition 1. It is also obvious from the diagram that there exists some interval $[\underline{\varepsilon}, \bar{\varepsilon}]$ such that $G(\hat{v}(\underline{\varepsilon})) > \underline{\varepsilon}$ and $G(\hat{v}(\bar{\varepsilon})) < \bar{\varepsilon}$, where $0 < \underline{\varepsilon} < \bar{\varepsilon} < 1$. In this example, the unique equilibrium values are: $\hat{b}$ = 0.2015, $\hat{r} = 0.4516$, and $\rho(\hat{r}) = 0.2202$.

[40] It is important to note that in none of our several numerical examples did we find a case of multiple equilibria. In a fairly general game with a structure that is somewhat similar to the game in paper, Cooper and John (1988) proved that strategic complementarity is a necessary condition for multiplicity of equilibria (proposition 1 of their paper). While this paper is not about multiple equilibria, the apparent absence of such equilibria, given strategic substitutability in the model, would appear to be consistent with Cooper and John's (1988) result. But this is actually not correct. In my model, *if* the bribe were independent of r, then the derivative in (12) will necessarily be negative because $\lambda'(r) < 0$ and so if a fixed point exists it will be unique. This is the reasoning behind proposition 1 in Cooper and John (1988). However, in our case the derivative in (12) could be positive for some range as shown above in example 2.

2.1.4 Social Welfare

We may write equilibrium social welfare -- focusing on *only* the payoff of customers[41] -- as:

$$\hat{W} = ((1-\pi) + \pi\rho(\hat{r},\hat{b})) \int_{\hat{v}(\hat{r})}^{\overline{v}} (v-\hat{b})g(v)dv + \pi\rho(\hat{r},\hat{b})) \int_{\underline{v}}^{\hat{v}(r)} vg(v)dv + \pi(1-\rho)\int_{\underline{v}}^{\overline{v}} vg(v)dv. \qquad (14)$$

The first term is the payoff of customers who are willing to pay the bribe weighted by the probability of meeting a corrupt official and the second term is the payoff of customers will report a demand for a bribe weighted by the probability of meeting a corrupt official whose supervisor is honest (i.e., a corrupt H-type official). The final term is the payoff of all customers weighted by the probability of meeting an honest H-type official.

Based on examples 1 and 2 in section 2.1.3, I evaluate social welfare for various values of π. The results are presented in tables 1 and 2 respectively.

3. Discussion of results

Given that I do not impose any restriction on the number of customers who can be matched with an official and given that a customer who is willing to report a demand for a bribe might end up meeting an honest official, r is not the proportion of customers who report demands for a bribe; it is the proportion of customers who are willing to report a demand for a bribe *if* they

[41] Excluding the payoff of corrupt officials from social welfare is consistent with an objection that George Stigler raised against Gary Becker's formulation of the social welfare of crime wherein the gain to the criminal is included in social welfare. According to Stigler (1970, p. 527) "Becker introduces as a different limitation on punishment the "social value of the gain to offenders" from the offense. The determination of this social value is not explained, and one is entitled to doubt its usefulness as an explanatory concept: what evidence is there that society sets a positive value upon the utility derived from a murder, rape, or arson? In fact the society has branded the utility derived from such activities as illicit. It may be that in a few offenses some gain to the offender is viewed as a gain to society,' but such social gains seem too infrequent, small, and capricious ... "

meet a corrupt official. However, for the sake of exposition, I use the expressions "the measure of reports" and "the measure of customers who are willing to report" interchangeably.

In example 1 of section 2.1.3, the equilibrium is locally stable because I found that the $G(\hat{v}(r))$ curve cuts the 45-degree line from above.[42] The equilibrium shows that although 90% of higher-ranking officials (supervisors) are honest, it is possible to be in an equilibrium where only about 17% of customers are willing to report corrupt behavior to higher authorities even though almost 1.6 times this measure (27%) of H-type officials are corrupt. In fact, every customer believes that the proportion of *corrupt* officials who are type-H is $\lambda(\hat{r}) = 71\%$. As explained previously, the strategic substitutability of reports accounts for such low levels of reports.[43]

However, another effect that accounts for the low level of reports is a strategic response of corrupt officials to higher levels of π. When π is increased, the corrupt officials reduce the bribe in order to deter customers from reporting corruption. For example, using the parameters and distribution functions in example 2 and solving for the optimal bribe as a function of π gives

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[42] An equilibrium, say r*, is locally stable if the derivative in (12) evaluated at r* lies in the interval (−1,+1). Otherwise, it is locally unstable. Geometrically, an equilibrium is locally stable if the $G(\hat{v}(r))$ line crosses the 45-degree line from above and it is unstable if it crosses the 45-degree line from below. Evaluating the derivative in (12) to determine stability requires knowing the closed-form expression for $\hat{b} = \hat{b}(r)$. However, given the distribution function in example 1 in section 2.1.3, my math software is unable to find a closed-form expression for $\hat{b} = \hat{b}(r)$. Therefore, I proceed as follows: given r*, I choose some $r_e \in [r^* - \xi, r^* + \xi]$ and find the bribe that maximizes (8), where $\xi > 0$ is very small. Call the optimal bribe $b^* = b^*(r_e)$. Then I use b* and the chosen value of $r \in [r^* - \xi, r^* + \xi]$ to compute $G(\hat{v}(r_e))$. Suppose $G(\hat{v}(r_e)) > r_e$. Then the actual measure, $G(\hat{v}(r_e))$, of reporters is greater than the expected measure, r_e, of reporters. Hence, we expect the customers to revise their expectations upwards towards r*. Therefore, if $r_e < r^*$ and $G(\hat{v}(r_e)) > r_e$, then r* is a locally stable equilibrium (i.e., the $G(\hat{v}(r_e))$ line crosses the 45-degree line from above). On the other hand, if $r_e > r^*$, then the equilibrium is not locally stable because the customers will revise their expectations downwards away from r*. I use a similar reasoning for $G(\hat{v}(r_e)) < r_e$. I chose $\xi = 0.000001$.

[43] This result is not driven by the low discount factor (i.e., $\delta = 0.1$) in the example because this parameter is a characteristic of the officials not the customers.

$$\hat{b}(r,\pi) = \frac{0.05555\left(-5r(1-\pi)+\sqrt{25r^2-230\pi^2+205\pi^2r^2+180\pi r(1-\pi)}\right)}{\pi(1-r)}$$. Using various values of r and plotting this function against π on the domain [0,1] reveals that the optimal bribe is decreasing in π. This is very easily seen in proposition 2 as I explain below. Therefore, low level of reports is not only driven by strategic substitutability among the reports of the customers.

It is important to note that while the preceding paragraph discussed the negative relationship between the bribe and π, it did not take into account the fact that the equilibrium measure, r, of customers who are willing to report corruption may also change with π. In the case of proposition 2, r does not change with π. In the case of proposition 1, it does. This case is illustrated in table 1 (after appendix A) which shows that there may still be a negative relationship between the bribe and π even if r adjusts to π.[44]

Proposition 2 shows that the low level of reports could be extreme. In this unique equilibrium, no one is willing to report corruption regardless of the proportion of honest officials (i.e., for any $\pi \in (0,1)$). As π rises, the officials reduce the size of the bribe. A smaller bribe and the common belief that no one will report corruption sustain this equilibrium. The lower-ranking officials nullify any effect of an increase in π on the incidence of corruption by reducing the size of the bribe (i.e., $\partial b^*/\partial\pi = -\underline{v} < 0$).

In table 1, the equilibrium measure of reports is *decreasing* in π. The reverse scenario is illustrated in table 2 where the equilibrium measure of reports is *increasing* in π. According to the derivative in (5a), an increase in π increases the customer's belief, λ, that an official who demands a bribe is type-H. All things being equal, this increases the measure of reports

[44] This table is based on example 1 of section 2.1.3.

according to (7). But since reports are increasing in the bribe, whether the equilibrium measure of reports actually increases depends on the effect of π on the bribe. In table 2, the bribe is increasing in π, so clearly the equilibrium measure of reports increases with π. But in table 1, the bribe is decreasing in π, so the equilibrium measure of reports need not increase with π.

Note, for example, that in the equilibrium in example 1, it is the action of the few C-types (10% of them) that supports the system of corruption. These officials punish customers who report corruption by refusing to serve them after an unsuccessful report. Hence, although a *successful* report to an honest superior imposes no cost on customers and there are 90% of such officials, Bayesian updating -- based on the reports of other customers -- leads the customers to believe that there is a $1 - \lambda(\hat{r}) = 29\%$ chance of reporting a corrupt official who will turn out to have a corrupt supervisor. By punishing customers who lodge unsuccessful complaints, the actions of a small proportion of corrupt officials (i.e., type-C officials, who do not face any risk of punishment) can support systemic corruption by making it more attractive for other officials (i.e., type-H officials) to engage in corruption. In fact, as shown above, type-C officials also choose the bribe while type-H officials take it as given. Hence type-C officials are the leaders of this corrupt system.

In example 2, the proportion of customers who are willing to report corruption is much higher than in example 1 (i.e., 45% versus 17%) although the parameter values for δ and π are the same. Of course, the distribution functions are not the same in these examples. It is not the point of this paper that customers are *necessarily* apathetic when it comes to reporting corruption.[45] However, as shown in proposition 2 and example 1, the point is that under conditions that are arguably very favorable, apathy by customers in reporting corruption could be very high. Among others, conditions on the distribution functions for the extreme case of zero

[45] However, even in this case, only 20% of customers are willing to report corruption if $\pi = 0.7$.

customer reports are stated in proposition 2. In the case of low but positive reports, the analysis does not easily lend itself to the restrictions that must be placed on the distribution functions for these very low but positive levels of reports to occur even though π is very high. But even without going through such an analysis, we can, based on previous discussions, identify three factors that account for low reports: (i) how high the bribe is, (ii) the density of valuations because customers' valuations affect the incentive to report,[46] and (iii) the strategic substitutability of customers' reports. The first two effects are obvious. The point of this paper is to draw attention to the importance of the third effect.[47]

One may argue that there is nothing wrong with low levels of reports and that the equilibrium in proposition 2 is socially desirable outcome because all the customers are served, so the bribe in this equilibrium has no efficiency effects and is therefore purely redistributive.[48] It is indeed possible to construct examples where social welfare, as defined in equation (14), is at its highest level when π is very high while both the equilibrium bribe and reports are at their lowest level. This is the case in the example in table 1. It is clear from the table that the bribe and the reports move in the same direction. In this example, welfare is increasing in the proportion (i.e., π) of honest supervisors, although the reports are decreasing in π. This is because although a higher π reduces reports, it also leads to a more than proportionate fall in the bribe which causes the proportion, $\rho(b, r)$, of corrupt H-type officials to fall.

[46] Points (i) and (ii) imply that since it is "high-valuation" customers who are less likely to report corruption, the extent to which the bribe affects the incentive to report depends on the distribution of valuations (e.g., how much mass is concentrated on "high" valuations).
[47] On the preceding point, it would appear that in examples 1 and 2, we could maintain everything else but change the distribution of the customers' valuation in order to investigate the effect of the distribution of customers' valuations on the equilibrium of the model. But this will not be helpful because there are confounding effects. The bribe responds to not only the distribution of customers' valuations but also to the probability of reports. And the bribe also affects the probability of reports. So there is a circular or bilateral process here where the bribe affects reports and the reports affect the bribe.
[48] For a review of the controversial argument that bribery may actually enhance welfare and may be seen as "speed money" in second-best environments, see Bardhan (1997).

It is important to note that in both examples 1 and 2, social welfare is increasing in the proportion of honest supervisors but not necessarily so in the equilibrium measure of reports. In the example in table 1, welfare is decreasing in equilibrium reports (as noted above) while it is increasing in the equilibrium reports in the example in table 2.[49] The difference is due to how changes in the reports affects the equilibrium bribe and the equilibrium measure of corrupt H-type officials.

To elaborate on the preceding point, recall that in the equilibrium in proposition 1, the equilibrium report may change in response to π. When there is an increase in the measure of customers who are willing to report corruption, the equilibrium bribe may also increase as shown in tables 1 and 2. An increase in reports and the bribe have opposing effects on the measure of corrupt type-H officials. However, if the effect of higher reports sufficiently dominates the effect of a higher bribe, so that there is a *sufficient* fall in the measure, $\rho(b, r)$, of corrupt type-H officials, then there will be an increase in welfare. Otherwise, there will be a decrease in welfare. Hence, a government will prefer an increase in reports depending on how sensitive the measure of corrupt H-type officials is to an increase in reports.

Although social welfare, as defined in (14), may be high even if reports are low (as in table 1), a government might nonetheless prefer higher reports. To the extent that demanding a bribe is an abuse of one's official power and bribery --- as modeled here --- is a form of extortion, a government that wants to promote fair-mindedness, integrity in the civil service, and discourage such illicit conduct may care more about getting people to report corruption rather than creating a culture of silence. As Klitgaard (1988) observed "[E]xtortion is a particularly debilitating form of corruption … It leads not only to inefficiencies but the alienation of citizens

[49] In a model without reports of corruption or higher-ranking officials, Ahlin and Bose (2007) find that social welfare may be non-monotonic in the proportion of honest officials.

from their government." Furthermore, if a majority of those who want the service (e.g., health care) are poorer than the government officials, then bribery leads to a transfer of income from the poor to the rich and thus worsens inequality and poverty (e.g., Sanjeev, Davoodi, and Alonso–Terme, 2002). Therefore, a government that cares about inequality may prefer higher equilibrium reports. Also, using Peruvian data, Hunt (2007) found that "... victims of misfortune ... are much more likely than non-victims to bribe public officials. Misfortune increases victims' demand for public services, raising bribery indirectly, and also increases victims' propensity to bribe certain officials conditional on using them, possibly because victims are desperate, vulnerable, or demanding services particularly prone to corruption."

The arguments in the preceding paragraph *appear* to have the flavor of non-welfarist approaches to social policy. But they aren't. If the government cares about inequality between government officials and the customers, then (14) is not the correct social welfare function. The government's concern about inequality implies that we have to take into account the income of the corrupt government officials; this includes their initial exogenous income *and* the bribe received. Then using an inequality-averse social welfare function such as Atkinson's social welfare function with a sufficiently high inequality-aversion parameter, one can show that social welfare is higher with higher reports even in cases where social welfare, as defined in (14), is decreasing with reports. Or if as in Klitgaard (1988) and Hunt (2007), bribery takes the form of extortion and can alienate a government from its citizens, then we may have a direct disutility of extortion, say C(b), which enters negatively into the social welfare function. Furthermore, a government may value higher reports in a given government agency because it creates a culture of accountability that may have beneficial externalities in other government agencies. These are normative arguments.[50] In addition, a key contribution of this paper is a positive argument which explains why reports by victims of corruption may be low even though there is a very high proportion of honest higher-ranking officials from whom redress could be sought.

In reality, the proportion of honest supervisors, π, is so low in very corrupt societies that the only possible equilibrium is $r = 0$. The point of this paper is to show that even if, as part of anti-corruption efforts, π is increased to a reasonably high level, we could be stuck in a high-corruption equilibrium with relatively few whistle blowers or no whistle blowers. Therefore, $r = 0$ may be the unique equilibrium *even if* a sufficiently high proportion of higher-ranking officials are honest.[51] This is what proposition 2 says.

One may argue that the assumption that a customer who lodged an unsuccessful report is not served makes the cost of reports too high and biases the results towards low reports. This argument is not correct for the following reasons: (a) even when the *expected* cost of an

[50] These arguments are consistent with Kaplow and Shavell (2001, p. 285) who opine that "... individuals may have a taste for adherence to a principle of fairness; that is, their utilities might be higher if a policy embodies some notion of fairness ... In this case, the taste for fairness would be relevant under purely welfarist assessment, just as any other taste would ... some notions of fairness and justice (such as rights of individuals against the government) might usefully be incorporated in rules in order to constrain the behavior of agents who cannot be trusted to use their discretion to maximize social welfare ... teaching and inculcating principles of fairness and everyday morality are consistent with maximization of individualistic measures of social welfare, for belief in these principles (such as keeping promises) induces individuals to refrain from behavior (breaking promises) that would harm others."

[51] It would appear that it is optimal for every customer to always threaten to report a demand for a bribe in the hope that if the official is a type-H, he will give them the good without the customer paying a bribe. But such a threat is not credible for customers for whom $\lambda(r)v + (1 - \lambda(r))(0) < v - b > 0$; call them high-valuation customers. Customers for whom $\lambda(r)v + (1 - \lambda(r))(0) \geq \max[0, v - b]$ have a credible threat; call them low-valuation customers. However, the official does not know a customers' type and if corrupt type-H officials always gave in to these threats, they will get nothing from bribery. Therefore, they have to take the risk of calling the bluff of customers since the customer may be a high-valuation type, in which case the threat is only a bluff. These types will pay the bribe when their bluff is called. And while low-valuation customers will not pay the bribe if their bluff is called, this does not necessarily signal that they are low-valuation types because refusing to pay the bribe when their bluff is called is a *battle of wills* that high-valuation customers could also engage in. Notice also that by calling the customer's bluff, a type-H official may also be sending the message that he is a type-C official, so that reporting the demand for a bribe is a waste of the customer's time. Both players are uninformed about each other's type. Because of incomplete information on the part of both players, it reasonable to assume that the official does not budge. And even if the customer leaves with the threat that he will report the official, the official still does not budge because leaving may simply be a bluff by the customer to fool the official to capitulate. So essentially, this interaction is akin to *brinkmanship* between the official and the customer with the customer threatening to report the official if the official insists on him (customer) paying the bribe. So long as, for the reasons given above, the official does not budge, the analysis in this paper is correct. Also as explained earlier, bribery in my model takes the form of "corruption without theft", so there can be no mutually beneficial deal between the customers and officials.

unsuccessful report is low because there is a high proportion of H-type officials, we are still able to construct equilibria with low reports, (b) the conditions for zero reports in proposition 2 do not depend on a high cost of unsuccessful reports; when those conditions are violated we can obtain equilibria with a positive measure of reports, (c) if the cost of unsuccessful reports was very high, it would not have been possible to construct equilibria with positive reports, and (d) what drives the result is not a high cost of unsuccessful reports but rather the presence of strategic substitutability among reports.

Policies aimed at fighting corruption from above by recruiting some honest or highly incentivized supervisors have a lower chance of success if corruption takes the form of "corruption with theft."[52] Accordingly, to encourage whistle-blowers such policies must be complemented with policies that change the nature of corruption from "corruption with theft" to "corruption without theft." This requires better systems of accounting and monitoring. For example, an honest supervisor could give his subordinate a given number of licences all of which must be accounted for at the end of a given period. That way, a corrupt official can only engage in "corruption without theft."[53] Assuming that bribery took the form of "corruption without theft", this paper has explicitly modeled the incentives of customers to inform on officials and shown that even this relatively favorable type of corruption presents daunting challenges because the victims may be reluctant to report corrupt conduct.

[52] In a model without a formal analysis of customer reports, Shleifer and Vishny (1993) first made the argument that "corruption with theft" is harder to fight.

[53] Of course, the official could sell forged licenses. However, the customers are less likely to cooperate in this case. More importantly, this does not change the basic point that patrons of government services are more likely to report cases of "corruption without theft" than "corruption with theft."

3.1 Extensions and robustness

The model can be extended in other ways. One could explicitly model the behavior of the supervisors of the corrupt officials. For example, after receiving complaints from customers, proving that an official has indeed engaged in corruption is only possible after the number of complaints exceeds a threshold level and costly investigation has been undertaken. However, this is likely to reduce customers' propensity to report a corrupt conduct and so will strengthen the result that fighting corruption can be a herculean task.

Another extension is to allow signaling by supervisors. While honest supervisors have the incentive to reveal themselves, the corrupt supervisors have the incentive to mimic the honest supervisors because not doing so will mean that their subordinates' (cronies) types will revealed which will eliminate their (i.e., corrupt supervisors) illicit source of income. In this case, the honest supervisors, being public-spirited, will have an objective function such as the social welfare function in (14) while the corrupt supervisors' objective function will be a proportion of the illicit income of C-type officials. One can imagine the signal taking the form of the ease with which customers can lodge complaints. For example, this may be a 24-hour phone hotline which customers can call to initiate the process of lodging complaints. The fixed cost of this discretionary service must be financed by each supervisor from the budget allocated to his/her outfit. Then we can construct a separating equilibrium where the types of supervisors are revealed if the net benefit of this service is sufficiently high for honest supervisors than it is for corrupt supervisors. Otherwise, we can construct a pooling equilibrium where all supervisors invest in the same service and so our results will still go through. With the possibility of signaling by the supervisors, the lower-rank C-type officials may be forced to transfer a bigger proportion of their illicit income to their supervisors in order to make it worthwhile for them (i.e., their supervisors) to invest in the signal. This is especially so if the money invested in the signal used to be diverted by corrupt supervisors for their own private gain.

We can also relax the assumption that a C-type official is never fired if he is reported but an H-type official is fired if he is reported. Instead, we could assume that a C-type official is fired with probability, P_C, when reported and an H-type official is fired with a corresponding probability of P_H, where $0 < P_C < P_H < 1$. An official's type is his private information. This will still lead to the result that when an official demands a bribe when the probability of being reported increases, then a customer's belief that he is an H-type official falls; in this case, an H-type official is an official whose supervisor is more likely to fire him (i.e., $P_H > P_C$). Hence, the strategic substitutability of customers reports will hold even if the effect is weaker than in the extreme case of $P_H = 1 > P_C = 0$ considered in this paper.

Yet another extension is to relax the assumption or the feature of the model which ensures that the reports of the customers are credible. For example, suppose that a customer must pass a test in order to qualify for the service (e.g., a test for a driver's license, business permit, etc). Then when a customer complains to a superior about bribery, the superior cannot be certain that the customer is credible because he (the customer) may have truly failed the test or was unable to meet certain requirements. But, of course, the official may also have unfairly failed the customer in order to demand a bribe. As in Mookherjee and Png (1992) and Prendergast (2002, 2003), this may require the superior to engage in costly and, perhaps, imperfect investigation. In any case, if honest superiors do not necessarily trust customers' report of bribery, then this is likely to strengthen the result that few customers will be willing to report bribery. Hence, the paper's result is robust to such an extension.

The result of this paper could be applied to not only corruption but to other aspects of poor customer service in both the public and private sectors. We can re-define the bribe as the delay in customer service and the size of the bribe as the length of the delay. Delays reduce the welfare of customers while they increase the welfare of workers because it allows them to work at a slower pace.

One may argue that the mechanism for the persistence of corruption is fragile because as long as some victims report corrupt officials, this information will eventually spread in society and potential victims will then target officials with honest superiors. First, this is a moot point because there is indeed an equilibrium (i.e., proposition 2) in which no one reports corruption. Second, this criticism is applicable to any one-shot game of asymmetric information if one decides to re-cast it as a repeated game. For example, it is equally applicable to Akerlof's famous adverse selection result because in a repeated setting the lemons will eventually become public information and so, over time, there will be no adverse selection.[54]

4. Conclusion

I have built a simple model of corruption in which fighting corruption may still be very difficult under these favorable conditions because the victims of corruption are very reluctant to report it even if they believe that there is a very high chance of them getting redress.

The message of this paper is that demanding a bribe may be a signal that a corrupt official is well-connected in the upper echelons of an organization. In this environment of asymmetric information, it may be very difficult to control corruption. This perverse result is due

[54] It is also *well known* that informational cascades are fragile because a little public information can cause the equilibrium to unravel. Hence, in a repeated setting, the results of informational cascades are likely to be overturned. However, one cannot seriously claim that this literature has not led to useful insights.

to a strategic substitutability among the reports of customers which lead them to free ride on each other's reports.

Appendix A: Proof of Proposition 2

First, consider existence of the equilibrium. Recall that each customer is atomistic. Suppose that each customer believes that all other customers will not report corruption, so that r = 0. Then all officials will be corrupt.[55] So a customer's posterior belief that an official who demands a bribe is type-H is π. Then a customer will not report a demand for a bribe if $v - b > \pi v$ or $v > b/(1-\pi) \equiv \tilde{b}$. Hence, no customer will report a demand for a bribe if $v > b/(1-\pi)$ for all v. Given r = 0, each official chooses b to maximize

$$\tilde{\Omega}(b) = b(1 - G(\tilde{b})), \tag{A1}$$

where $\tilde{b} \equiv b/(1-\pi)$. Taking the derivative of (A1) with respect to b gives

$$\frac{\partial \tilde{\Omega}(b)}{\partial b} = 1 - G(\tilde{b}) - \tilde{b} g(\tilde{b}). \tag{A2}$$

The derivative in (A2) is non-positive if $1 - \tilde{b}\,\theta(\tilde{b}) \leq 0$ for all $\tilde{b} \in [\underline{v}, \overline{v}]$, where $\theta(v) \equiv g(v)/[1 - G(v)]$ is the hazard rate and $\underline{v} > 0$. Therefore, $\tilde{b} = \underline{v} = b/(1-\pi)$. It is obvious that given the out-of-equilibrium beliefs in the proposition, $b^* = (1-\pi)\underline{v} > 0$,[56] $r^* = 0$, and

[55] Note, however, that $\rho(r)$ in equation (2) is undefined for r = 0. This is because when r = 0, the weak inequality in (1) does not hold with strict equality for any b > 0.
[56] At this bribe-price, the customer with valuation $\underline{v}$ is indifferent between reporting and not reporting and so according to (6), he will report. But since this customer is of zero measure, the claim that r = 0 in this equilibrium is still valid. At the risk of belaboring the obvious, note that although the minimum valuation of customers is $\underline{v}$, the minimum expected price they are willing to pay is $(1-\pi)\underline{v}$ because with probability π they can get the service at a zero price (i.e., if report the demand for a bribe, then with probability π, they will meet an honest superior). Hence, at a corner solution the bribe must be $(1-\pi)\underline{v} > 0$.

$\rho^* = 1$ is an equilibrium.

Now consider uniqueness. Given lemma 1, there is no equilibrium with r =1. So to prove uniqueness, assume the contrary claim that there is an equilibrium with $r \in (0,1)$. An official chooses b to maximize

$$\Omega(b) = b\left(1 - G\left(\frac{b}{1-\lambda(r)}\right)\right). \tag{A3}$$

Then

$$\frac{\partial \Omega}{\partial b} = 1 - G(\hat{v}) - \frac{bg(\hat{v})}{1-\lambda(r)}\left[1 + \frac{b}{1-\lambda(r)}\frac{\partial \lambda}{\partial b}\right], \tag{A4}$$

where

$$\frac{\partial \lambda}{\partial b} = \frac{\pi(1-\lambda(r))}{\pi\rho(r) + 1 - \pi}\frac{\partial \rho(r)}{\partial b} > 0.$$

We can rewrite (A4) as

$$\frac{\partial \Omega}{\partial b} = 1 - G(\hat{v}) - \hat{v}g(\hat{v})\left[1 + \hat{v}\frac{\partial \lambda}{\partial b}\right]. \tag{A5}$$

Then $\underline{v} > 0$, $1 - \tilde{b}\,\theta(\tilde{b}) \le 0$ for all $\tilde{b} \in [\underline{v}, \overline{v}]$, and $\partial\lambda/\partial b > 0$ imply that $1 - \hat{v}\theta(\hat{v})[1 + \hat{v}(\partial\lambda/\partial b)] < 0$ for $\hat{v} \in [\underline{v}, \overline{v}]$. Therefore, the derivative in (A5) is negative for $b/(1-\lambda(r)) = \hat{v} \in [\underline{v}, \overline{v}]$. Hence, all customers will pay the bribe and be served since the optimal bribe is $(1 - \lambda(r))\,\underline{v} > 0$. But then no customer is willing to report corruption, so $r > 0$ cannot be an equilibrium. The contradiction and lemma 1 imply that the equilibrium in proposition 2 is unique. **QED**

As examples of proposition 2, consider two specific distributions with non-decreasing hazard rate functions and $\underline{v} > 0$.

(a) Suppose that v is uniformly distributed on [2,3]. Given r = 0, each official chooses b to maximize

$$\tilde{\Omega}(b) = b(1 - G(\tilde{b})) = b\left(3 - \frac{b}{1-\pi}\right), \tag{A6}$$

subject to $\tilde{b} \equiv b/(1-\pi) \in [2,3]$. Taking the derivative of equation (A6) with respect to b gives

$$\frac{\partial\tilde{\Omega}}{\partial b} = 3 - 2\tilde{b} \tag{A7}$$

Then $\partial\tilde{\Omega}/\partial b < 0$ for all $\tilde{b} \in [2,3]$. Hence, $\tilde{b} = 2$ maximizes equation (A6) and therefore, the optimal bribe is b* = 2(1 − π). Therefore, r* = 0, b* = 2(1 − π), and ρ* = 1 is a (unique) equilibrium. Note that for any $\pi \in (0,1)$, the bribe is chosen to satisfy b* = 2(1 − π), which is decreasing in π.

(b) Suppose that v follows a Weibull distribution with support $[\underline{v}, \infty)$ and distribution function $G(v) = 1 - \exp[-(v - \underline{v})]$, where $\underline{v} \geq 1$. Then

$$\frac{\partial\tilde{\Omega}}{\partial b} = \exp(-u)(1 - \tilde{b}), \tag{A8}$$

where $u \equiv (\tilde{b} - \underline{v})$. Given $\underline{v} \geq 1$, the derivative in (A8) is non-positive for $\tilde{b} \equiv b/(1-\pi) \geq \underline{v}$. Hence, r* = 0, $b^* = (1-\pi)\underline{v}$, and ρ* = 1 is a (unique) equilibrium.[57]

[57] The Pareto distribution has a decreasing hazard rate. However, assuming that v has the Pareto distribution $G(v) = 1 - (\underline{v}/v)^{\alpha}$, where $\underline{v} > 0$ and $\alpha > 1$, also gives this equilibrium. Of course, the non-decreasing hazard rate condition is not a necessary condition.

Table 1: Equilibrium values of reports, bribes, and welfare given $\delta = 0.1$, $F(s) = s^2$ on [0,1] and $G(v) = v^2$ on [0,1].

π	$\hat{r}$	$\hat{b}$	$\hat{\rho}$	$\hat{W}$
0.4	0.2237	0.2990	0.8721	0.4041
0.5	0.2112	0.2603	0.7656	0.4429
0.6	0.2007	0.2259	0.6556	0.4994
0.7	0.1911	0.1932	0.5417	0.5438
0.8	0.1817	0.1595	0.4179	0.5866
0.9	0.1712	0.1198	0.2725	0.6277

Table 2: Equilibrium values of reports, bribes, and welfare given $\delta = 0.1$, $F(s) = s$ on [0,1] and $G(v) = 1 - \exp(-v)$ on $[0, \infty)$.

π	$\hat{r}$	$\hat{b}$	$\hat{\rho}$	$\hat{W}$
0.4	0.1140	0.0842	0.6040	0.9331
0.5	0.1334	0.0928	0.5426	0.9333
0.6	0.1636	0.1040	0.4785	0.9345
0.7	0.2084	0.1196	0.4089	0.9375
0.8	0.2846	0.1449	0.3278	0.9431
0.9	0.4516	0.2015	0.2202	0.9548

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